Winemaking 401

Post-Fermentation Cellar Operations

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Table of Contents

Bulk Storage and Maturation

(prior to bottling)

- Maintaining proper free SO_2 Level
- Minimize oxygen exposure
- Maintain temperature (and humidity)
- Protect from (direct) sunlight

"Why" you may ask?

Free SO_2 Maintenance

- <u>0.8 PPM molecular</u> for whites and Iowa Reds (0.5 PPM "Big" reds due to protective phenolics)
- Remember: amount of sulfite addition needed to achieve this target is <u>pH dependent</u>
- Anti-microbial
- Anti-oxidant (more on this below)

Minimize Oxygen Exposure

- Whites and low-phenolic reds cannot consume much O_2 before suffering oxidative damage
- Minimize headspace in carboys and tanks
- Use low-exposure racking procedures
  (no splashing; purge lines/vessels with inert gas)
- Sampling paradox
  (Need to carefully watch the wine but each sample allows new O_2 into the headspace)
  Note: sampling valves in larger format vessels are a great investment

Temperature

- <u>Optimal cellar temperature</u>: 50-62F
  Lower-end provides good inhibition of micro-organism growth, esp. Brettanomyces
  Upper-end fosters phenolic development in "Big" reds
- Suboptimal temperature: 63-68F [the lucky amateur]
- <u>Problem temperature</u>: above 68F
- <u>Constant temperature</u> also helpful; faster settling-out; less "turn over" of headspace gases (esp. bottle aging)

Protect Wine from Sunlight

- Direct sunlight is known to damage wine
- No wine is afraid of the dark
- Conventional wisdom: Wine is best “elevated” in the dark

- In theory… indirect sunlight and electrical lighting can cause undesirable effects over long periods of time (esp. shorter wavelengths; hence, the oft heard prohibitions regarding fluorescent lamps).

Common Problems Encountered during Bulk Maturation of Wine

- Oxidation
- Volatile Acidity (VA) production (Acetobacter)
- Lactic acid bacteria proliferation/spoilage
- Film yeast
- Protein instability (most common "haze")

- Reduced sulfur odors (immediate post-ferment)

Wine Oxidation

- Dissolved O_2 in wine can readily reach the saturation level of 8 mg/L during a "splash" racking
- Phenolic development requires only 0.5 mg/L per month (micro-oxygenation)
- Excess O_2 drives many undesirable reactions, such as:

Oxidation (continued)

- Phenolic oxidation to quinones
  "browning"
- Hydrogen peroxide (H_2O_2) production which leads to oxidation of ethanol into acetaldehyde:

  Development of "nutty" or "Sherry-like" odors which "mask" fruit and desirable aromatics

Oxidation Prevention

- Maintain free SO_2 levels:
  - Binds with quinones to prevent polymerization
  - Neutralizes H_2O_2; less acetaldehyde production
- Maintain low dissolved O_2 levels:
  - Minimize “headspace”
  - Protect wine during racking/transfer
  - (e.g., use inert gas to purge lines and tanks)

Volatile Acidity (VA)

- Vinegar-like smells caused by excessive microbial activity:
  Acetobacter (requires oxygen)
  Lactic acid bacteria (gram-positive)

- Acetic acid + ethanol → ethyl acetate
  (nail polish remover – acetone)

- A little VA adds complexity but more than a little yields a spoiled wine (“Gourmet Vinegar”?)

VA Prevention

- Good cellar hygiene keeps bacterial populations from reaching an uncontrollable "head start"
- Keep storage vessels "topped-up"
- Keep cellar temperature low (slows metabolism)
- Maintain free SO_2 levels:
  - Antimicrobial in addition to antioxidant
  - Destroys bacteria cell membranes

Note: Lysozyme not effective against
Acetobacter or Lactic acid bacteria

Film Yeast

- *Candida microderma*
  Wild yeast that grows on surface of wine
  Forms a white film in the headspace
- Requires oxygen to proliferate
- Metabolizes ethanol into acetaldehydes (Sherry)

  <u>Prevention</u>:
  No headspace; maintain free SO_2;
  Keep cellar temperature below 55F

Primary Clarification

Red Wine Clarification

- Rack off the “gross lees” 24 hours after press (#1)
- Allow remaining yeasts and solids to settle during malolactic fermentation
- At end of MLF: rack to a sanitized vessel and sulfite to level indicated by wine pH (#2)
- Allow time for microscopic solids to agglomerate and then fall out due to gravity (slowed by CO_2; accelerated by phenolics). Check SO_2 and rack (#3)
- When wine “falls bright” rack, sulfite & bottle (#4)

Red Wine Clarification

- Red wine almost always “falls bright” on its own given the time required to do so accompanied by a few racking operations
- Many winemakers NEVER filter or fine their reds
- Slight “haziness” can occur due to excessive protein levels in low phenolic wines; or, high microbial levels (e.g., “stuck” MLF)
- In these rare instances, the winemaker has the option to perform a gentle filtering or fining operation as required to meet stylistic goals

White Wine Clarification

- Rack off gross lees and sulfite when fermentation is complete (verified by hydrometer and Clinitest™) (#1)
- Allow wine to gradually "degas" and drop sediment
- When wine "falls bright":
  Heat stabilize; cold stabilize; rack and bottle (#2)
- **MINIMIZE OXYGEN EXPOSURE WHEN RACKING WHITE WINE**

3. Minimize splash in receiving vessel (siphon; vacuum)
2. Purge vessels with inert gas
1. Use inert gas to purge vessel and push the wine (see below)

Racking Operations

Racking

- <u>Racking</u> is the term used to describe the transfer of wine from one vessel to another using a "racking cane" and tubing. It is a universal winemaking operation
- It serves the subsidiary function of separating clarified wine from its sediment

- It can be accomplished via:

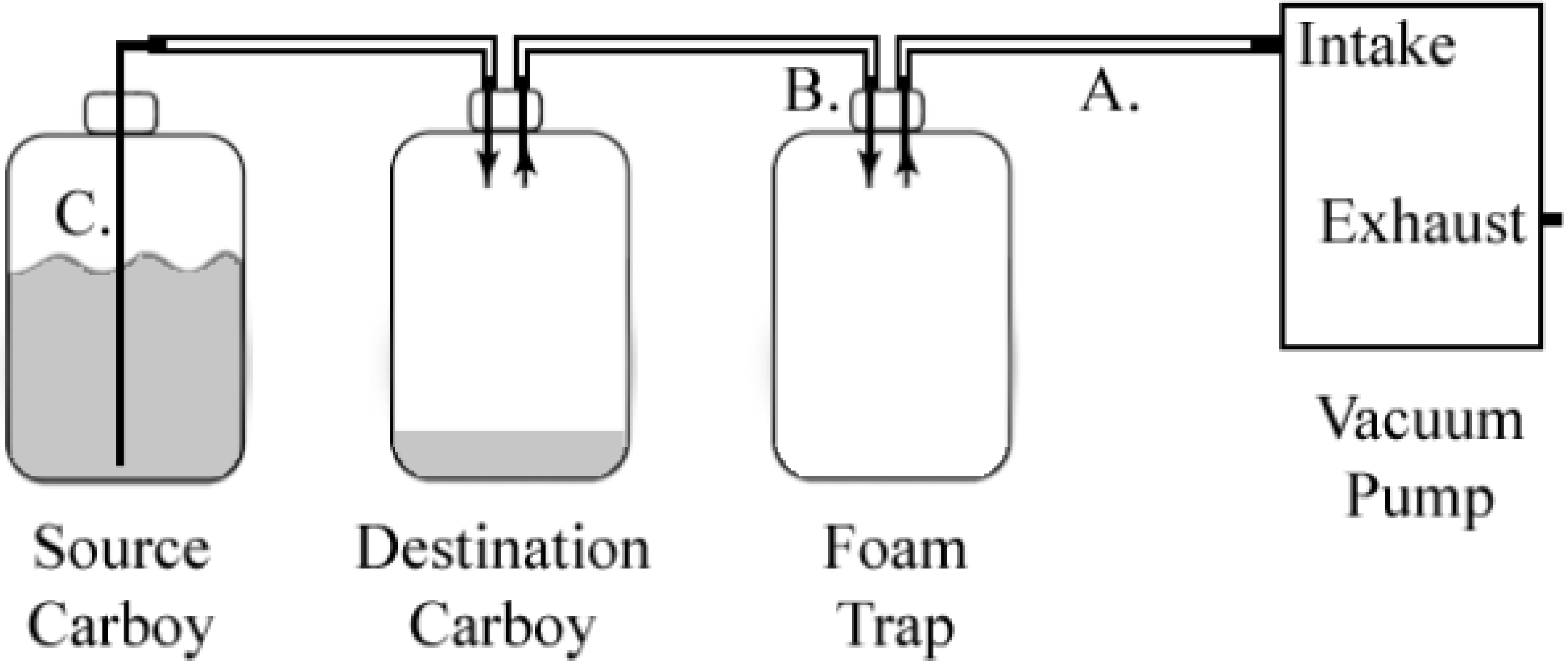
  Gravity-driven suction (Siphoning)
  Vacuum-pump driven suction (defying gravity)
  Pressurized inert gas pushing forces
  Food-grade sanitary transfer pumps (expensive)

Traditional Gravity Siphoning

(via Sterile Blow Tube)

Vacuum Racking Setup

(See in-class demonstration)



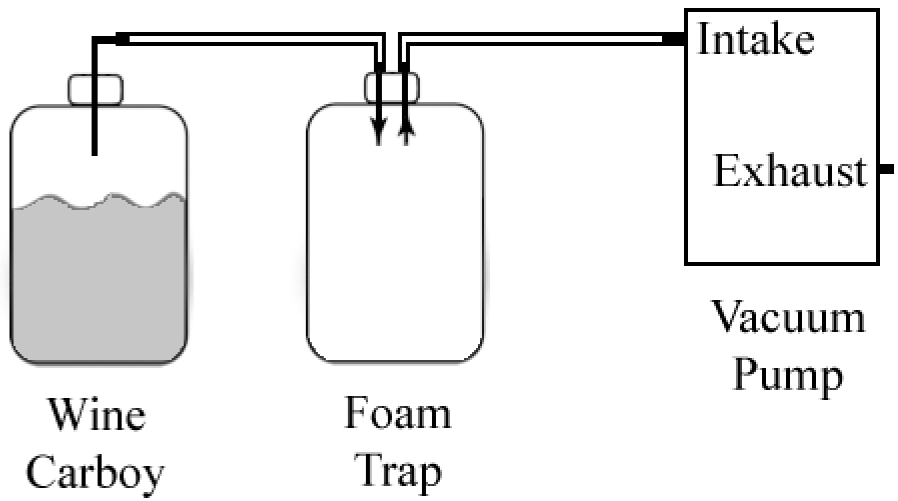
<u>Note the problem with the "Destination Carboy":</u>
"Splash racking" may be useful when racking red wine off the gross lees;
But is not advised for white wines once fermentation has finished.

<u>#1 Advantage of Vacuum Racking</u>:
Defying gravity and its coincidental reduction in the aggravation of my bad back!

http://www.moundtop.com/vacuum/vacuum-racking-procedure.pdf

Vacuum Degassing

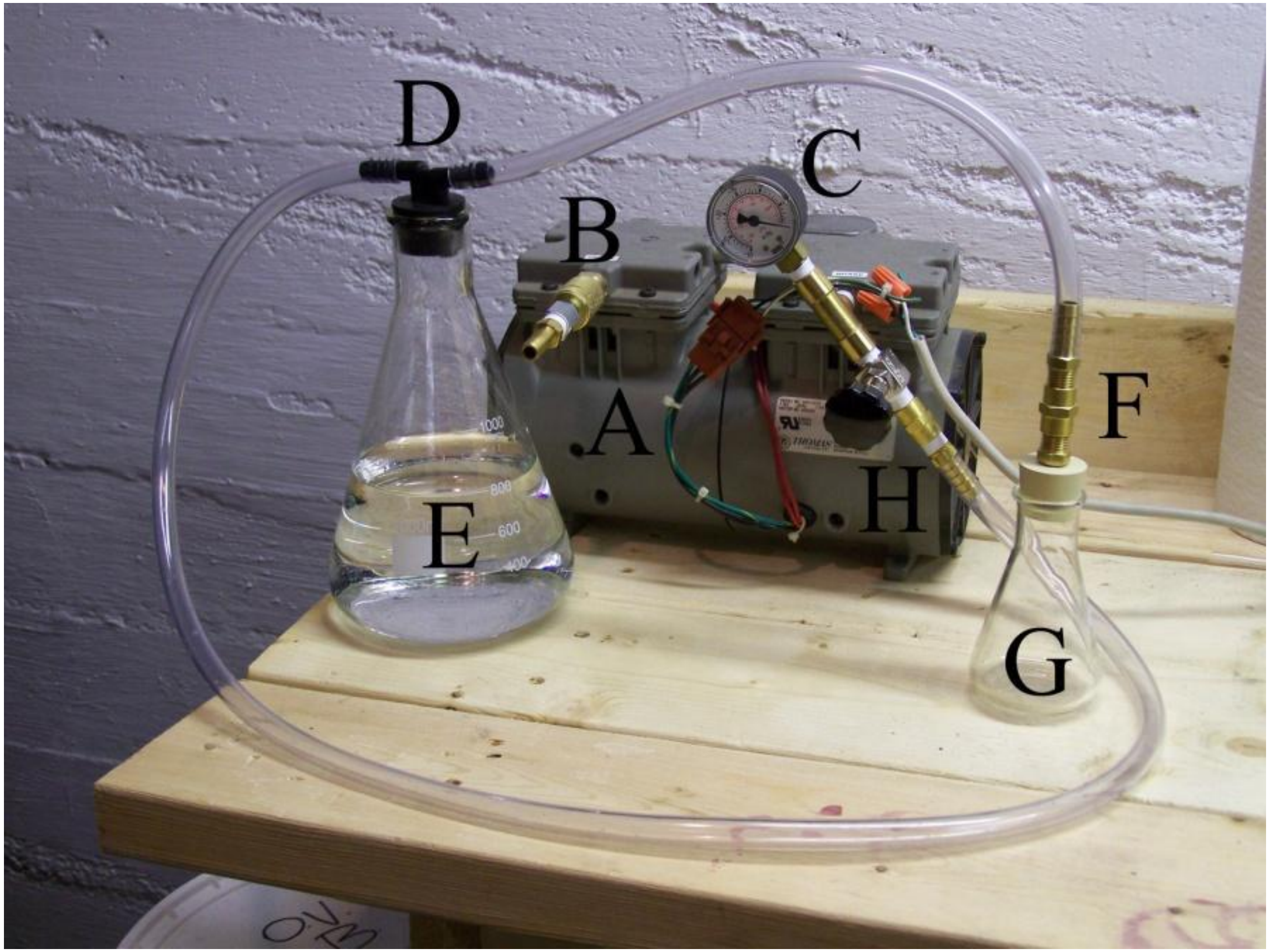
(Additional benefit of vacuum-pump setup?)



Bulk degassing in a carboy is tricky business. Many wines do not easily give up their dissolved CO_2 – especially at cool cellar temperatures. Providing some "rough surfaces" in the wine can provide sites to help gas bubbles form (like "boiling stones" in a distillation setup).

Personally, I never vacuum degas and prefer the wine to degas at its own pace. Besides, I've never made a wine that didn't benefit from a year in the cellar.

Multi-Purpose Vacuum Pump



A. Vacuum Pump
B. Exhaust Port
C. Vacuum Guage
D. 2-port Bung
E. Foam Trap
F. 1-Port Bung
G. Degassing Flask
(for test samples)

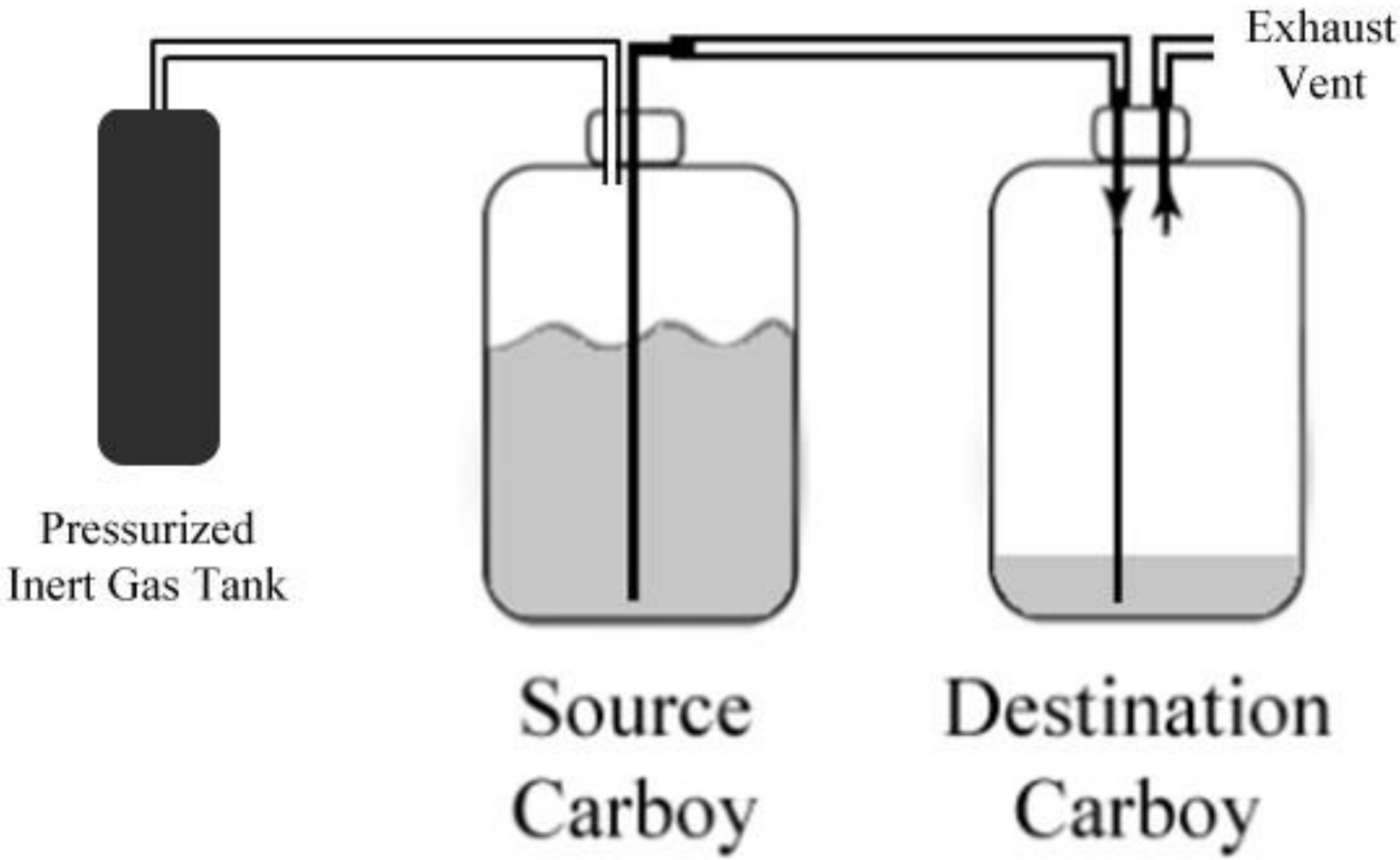
Dual-Port Bungs for Vacuum Racking

Inert Gas for Racking/Topping/Sparging

Inert Gas Cylinder

Nitrogen/Argon Gas Regulator with Flowmeter

Pressurized Inert Gas Racking Setup



Flextank Maturation Vessel

You cannot rely on gravity-based siphoning to move wine in and out of a large-format vessel like this 30 gallon Flextank.

Vacuum (pulling) or pressurized inert gas (pushing) techniques work well in these contexts (but keep an eye on the vacuum process to prevent "collapse" of receiving vessels with soft walls).

Food-grade pumps also work well (but they are very expensive).

Wine Stabilization

Wine Instability

Newly fermented wines are characterized by several classes of “instabilities” which make them vulnerable to undesirable transformations during bulk maturation or post-bottling.

3 Major Forms of Wine Instability

- Tartrate Instability
- Microbial Instability
- Protein Instability

Tartrate Instability

- Newly fermented wines are usually supersaturated with tartaric acid because ethanol reduces its solubility
- Supersaturated tartaric acid WILL eventually “fall out” of solution in the form of yellow-white flakes or crystals in whites or dark sediment in red wines (so-called “wine diamonds”)

Cold Stabilization

- Supersaturated tartaric acid can be "coerced" out of solution by subjecting the wine to a cold environment for approximately 2 weeks
- Chilling the wine to around 25-30F reduces the solubility of tartaric acid to the point that it is forced to crystalize and fall out as sediment
- Once racked off the cold-induced crystalized sediment the wine is "cold stabilized" and is unlikely to throw sediment in the bottle

Note: Perform Bentonite fining of whites prior to cold stabilization to take advantage of the *lees compaction* provided by tartrate crystal fall out.

Winemaker’s Chilling Cabinet

(Cold stabilization; Cool White Ferments; Disgorging; “Jacking”)

High-Efficiency Freezer Chest

Insert Temp Probe via Drain Plug

Johnson Controls External Thermostat

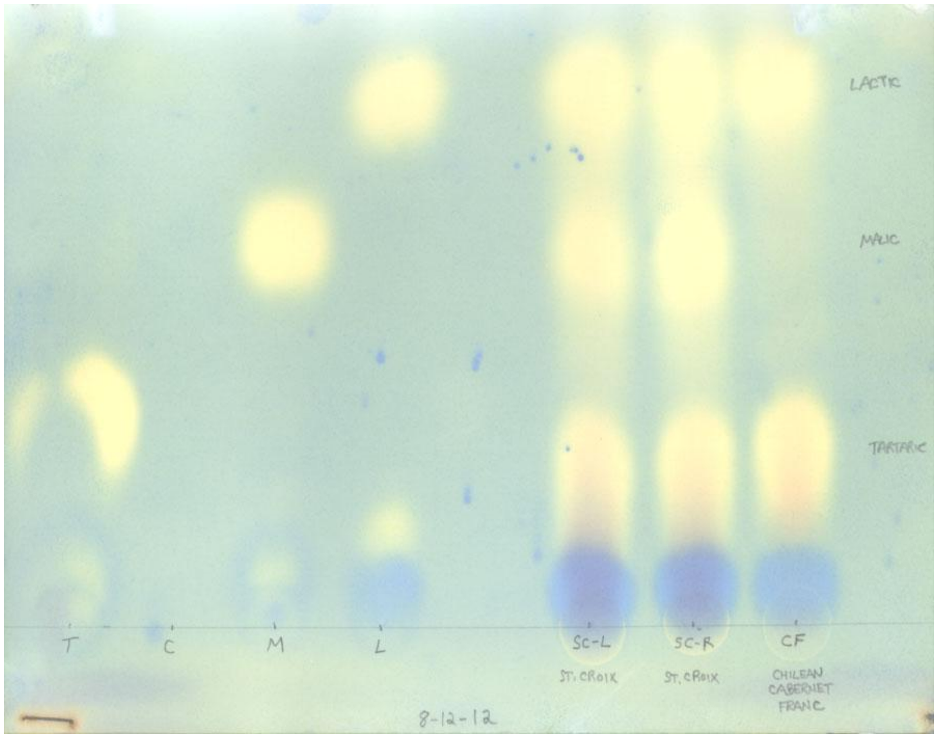
Microbial Instability

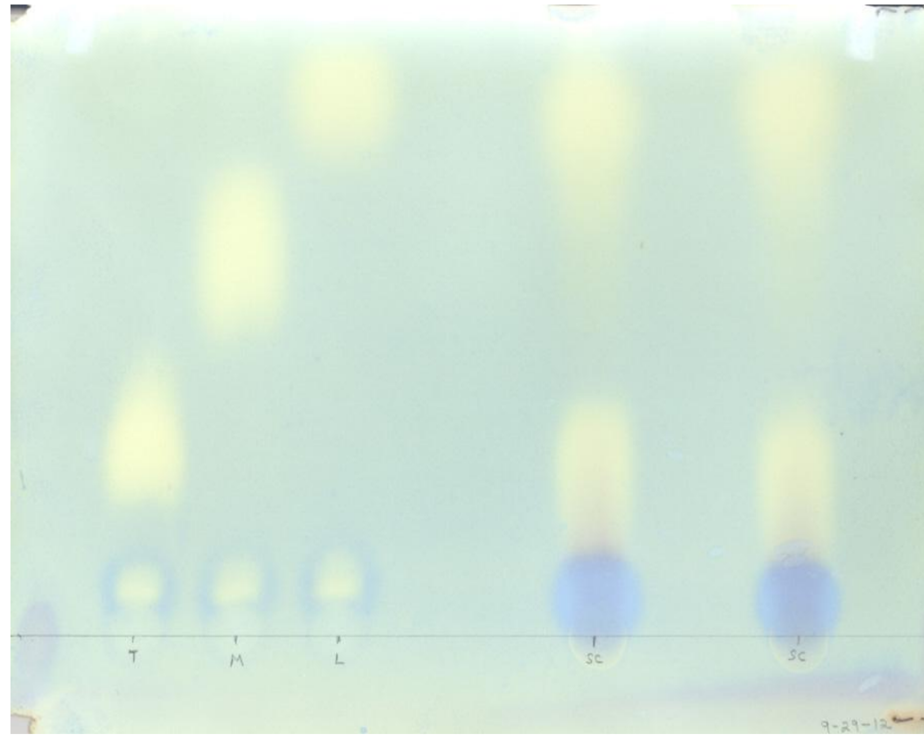
- At the completion of alcoholic fermentation most wine contains significant amounts of malic acid
- Malic acid is a nutrition source for a common family of bacteria found in all wines (so-called malolactic fermentaion)
- If MLF occurs in the bottle, the wine will throw sediment, become fizzy and cloudy and may develop off-flavors and aromas
- Hence, wine with significant levels of malic acid are said to suffer by microbial instability

Microbial Stabilization

- Red wines are typically innoculated with robust strains of malolactic bacteria to foster MLF during bulk maturation prior to bottling
- MLF converts the malic acid to lactic acid and renders the wine more <u>microbially</u> <u>stable</u>
- Flavors produced by MLF are incompatible with most styles of white and rosé wines
- Early addition and maintenance of SO_2 can prevent MLF despite the presence of malic acid
- Lysozyme enzyme kills malolactic bacteria and can be used to inhibit MLF in high pH wines

Qualitative Evaluation of MLF Progress using Paper Chromatography





<u>2012 Iowa St. Croix at post-press racking</u>
August 12
<u>Note</u>: Both batches of St. Croix show significant amounts of Malic acid present
(note greasy fingerprint for Tartaric reference)

<u>2012 Iowa St. Croix (7 weeks later)</u>
September 29
<u>Note</u>: Near absence of Malic acid
Add sulfite in 2 weeks

Protein Instability

- Newly fermented white wines usually have significant levels of free (unbound) proteins

- Given the passage of time, these small proteins will begin to agglomerate and become large enough to produce an unsightly haze and/or yellow-white flakes and sediment

- Wines with excessive levels of free proteins are said to be "heat unstable" as exposure to warm storage conditions usually fosters the haze formation process

  The high phenolic content of *Vinifera* red wines serves to "bind up" proteins which then settle-out during bulk maturation in the cellar [Light-bodied hybrid reds/rosés?]

Protein Instability Assessment

Heat Stability Tests have been developed to identify wines with excessive free protein levels:

(1) Hot Water Bath Test
(2) Boulton Ethanol Assay

Protein (Heat) Stability Testing

Hot Water Bath Test:

(1) Fill hot water bath[1] with enough water to cover most of the test bottle(s)
(2) Bring heat up to 80C (176F)
(3) Add sample bottles to hot water bath for 1 hour
(4) Remove samples and allow them to cool to room temperature (very important)
(5) Evaluate sample(s) for haze/clarity (e.g., penlight flashlight in darkened room <= 10 NTU)
Professional labs perform a semi-quantitative analysis using a Turbidity Meter

The heat exposure "denatures" the proteins which then precipitate out of suspension during the cooling process.

[1] An old CrockPot™ is used for heat stability testing in my wine cellar/lab.

Protein (Heat) Stability Testing

<u>Ethanol Assay Method</u>:

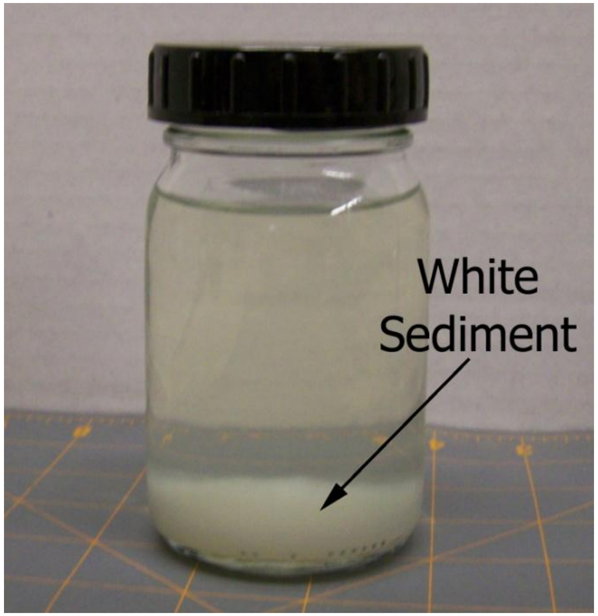
(1) Thoroughly mix 10ml of degassed wine with 10 ml of ethanol (e.g., Everclear™ or denatured alcohol)
(2) Evaluate the sample for haze/clarity

If the wine is heat unstable, the mixture will become hazy almost immediately.

However, the mixture will also turn hazy if significant levels of free polysaccharides and/or mannoproteins are present. This nonspecificity of the ethanol assay is both a strength and a weakness.

Wines that are found to be unstable by these tests should be fined to remove excess free proteins (since these materials are too small to be removed by conventional filtration techniques). The most common approach to achieving protein stability in white wines is <u>Bentonite fining</u> (see below)

Ethanol Test Results



Equal parts of hybid white wine and denatured alcohol (less expensive than ethanol/Everclear).

This wine had high levels of protein and some “gelatinous” fallout indicative of pectin haze risk.

Fining

Fining

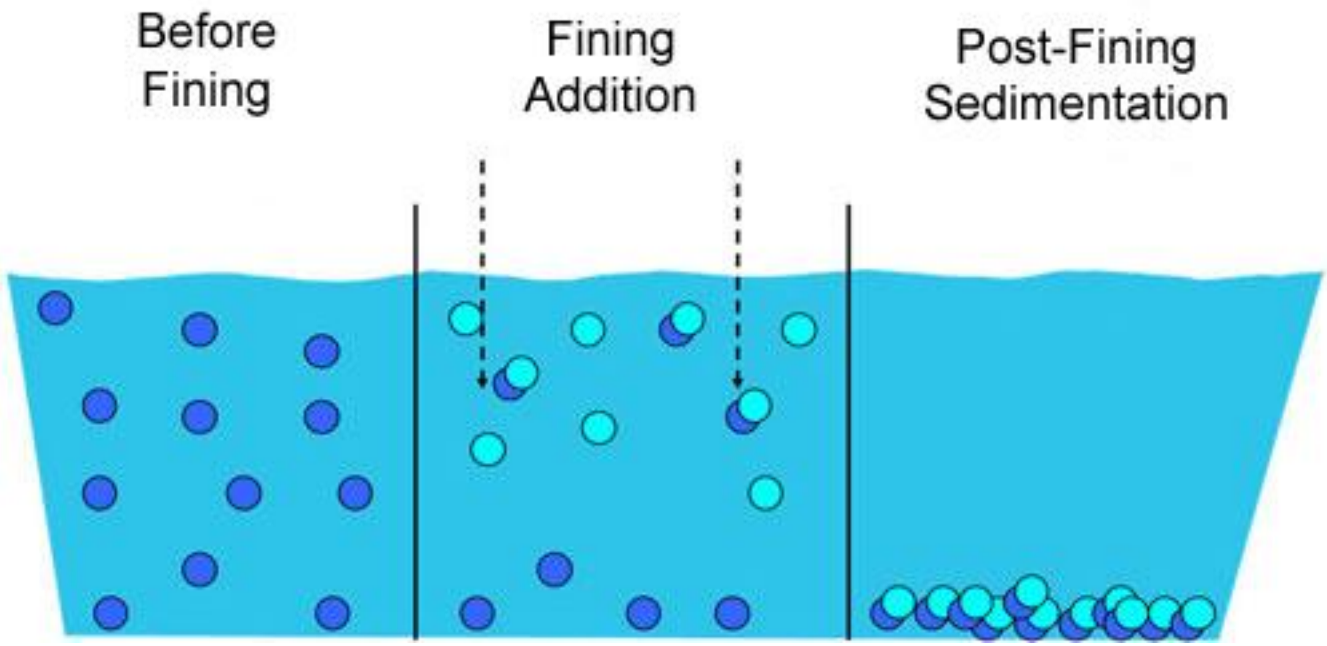
Temporary additions to wine which bind to nuisance compounds and remove them via sedimentation/filtration

- Corrects a defect; Makes a good wine better
- Unlikely to save a bad wine
- "Trade-off" is the most common result:

  Cost of attenuating an undesirable element is usually a coincident attenuation of a desirable one (e.g., aromatics; color; mouthfeel)

Fining Mechanisms

(1) Adsorbance (2) electrostatic charge (3) hydrogen bonding



Factors Influencing Fining Efficiency

- CO_2 gas in young wine tends to keep particulate matter in suspension
- pH changes interact with the *isoelectric points* of proteins (changing their solubility/stability)
- Temperature strongly affects enzymatic fining
- Cold stabilization after fining operations can yield significant lees compaction
- Never premix fining agents when multiple fining strategies are planned

Common Problems/Treatments

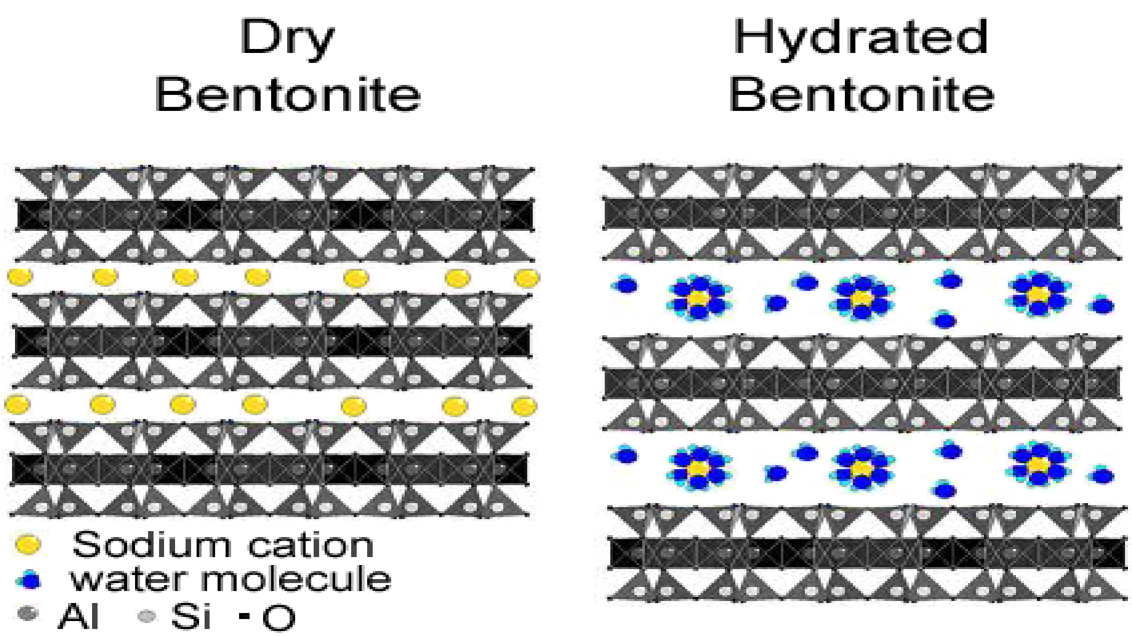
Problem	Description	Fining Agent
Unstable Protein (+)	Haze; Off-white flakes	Bentonite
Unstable Protein (-) Non-specific colloids (-)	Haze; Off-white flakes	Sparkalloid (Hot-Mix) Silica gel/Chitin[1]
Pectin	Haze	Pectinase enzyme(s)
Small-chain phenols	Bitterness (unripe seed tannins)	PVPP; Mask with oak/tannins
(slight) oxidation	Browning; Oxidative off-flavor	PVPP
Excess Tannin[2]	Mouth-puckering astringency	Gelatin/Silica gel; Egg whites (Pinot Noir)
H_2S; thiols	Sulfurous off-odors	Copper sulfate; Redulees; (Bocksin; Kupzit)

[1] Chitin (e.g., Chitosan) is derived from zooplankton exoskeletons (Shellfish alergy?)

[2] Not likely to be observed in cold-climate grape hybrids

Bentonite Fining

- Bentonite is a highly structured clay material. When properly hydrated, its matrix opens-up to expose many sites which have an affinity for positively charged free proteins



A simplified model of Bentonite fining is to assume that Bentonite has a NEGATIVE charge which allows it to attract POSITIVELY charged free proteins, bind to them and then "settle out".

Bentonite Fining

- *KWK* and *Vitiben* are common brands of Bentonite (fossilized volcanic ash; named for Ft. Benton, MT)
- 6 parts Bentonite are required to remove 1 part of free protein. Since free protein levels varies between 10-200 mg/L then the theoretical dosage varies from 0.06-1.8 g/L
- Bentonite dosage < 0.5 g/L has negligible effects on sensory profile (and often yields heat stability)
- Higher dosages can begin to strip color, aroma and other sensory attributes (esp. if > 1 g/L)
- Bench testing is ALWAYS warranted.

Bentonite Fining

Preparation of 5% Bentonite Slurry

(for bench testing)

(1) Add 475 ml of boiling distilled water to a previously “sanitized” blender
(2) Turn-on blender at “low” speed
(3) Gradually blend-in 25 g of Bentonite granules
(4) Blend for 2 minutes
(5) Transfer blender contents to 500 ml flask (Discard coarse/heavy sediment)
(6) Store in refrigerator over-night (to allow full hydration of mineral matrix)
(7) Stir immediately prior to use the next day

Discard after 48 hours to avoid any possibility of microbial build-up

Treatment Formula

ml of 5% slurry = (Bentonite dose (g/L) * gallons * 3.785 L/gal) / 0.05 concentration

Dosage Guidelines

0.25 g/L	Light treatment
0.50 g/L	Moderate treatment
1-2 g/L	Heavy treatment (risk of sensory impact)

Bentonite Fining

Typical Bench Trials

(1) Fill four sample jars with 100 ml of wine
(2) Add 0 (control), 0.5, 1 and 2 ml of slurry, respectively
    (To examine the effects of 0.25, 0.5 and 1 g/L dosages)
(3) Mix the Bentonite into the samples in such a way as to approximate the amount of mixing that will occur in the actual wine. This is usually not a problem for amateurs making small batches of wine; but becomes a critical "art form" for those treating large tanks.
(4) Allow the mixtures to settle (at least 48 hours – waiting is the hardest part).
(5) Carefully draw small subsamples from each bottle and test for heat stability.
(6) Evaluate the color, clarity and aroma of the remaining sample in each bottle.
    (The amount of accumulated sediment is also informative)
(7) Estimate the minimum dose required to achieve heat stability.
(8) Treat the target batch of wine accordingly.

Bentonite Fining

- Prepare hydrated Bentonite slurry (maybe 10% instead of 5%)
- Calculate amount of slurry required for desired dosage
- Add slurry slowly to wine while constantly stirring (slowly in a nearly full carboy to minimize oxygen exposure)
- Continue to slowly stir for 5-10 minutes
- Optional: Wait 48 hours and stir-in a small dose of silica gel (to bind-up Bentonite still in suspension and aid lees compaction)
- Wait 2 weeks for Bentonite to settle
- Cold stabilize for 1-2 weeks (lees compaction) and rack off sediment
- Allow wine to settle in carboy(s) for 1 month prior to bottling (Repeat ETOH Assay for added security)

- If wine fails the ETOH follow-up or develops even a trace of haze, consider other fining treatments (esp. Sparkalloid or Chitosan/Kieselsol)

Misc. Bentonite Facts

- Bentonite will adsorb odors from the air. Seal tightly and replace every year (its cheap)
- Fining mechanism is fast (15 min if stirred) but additional time is required for settling out
- Treated wine should not be colder than 50F
- Bentonite throws a large amount of lees if not accompanied by silica gel (Kieselsol) and/or cold stabilization follow-up.
- Two small doses of Bentonite work better than a single large dose (e.g., 2 x 0.25 g/L vs. 1 x 0.5 g/L)
- 1 g/L of Na-Bentonite (N. America) adds about 15 mg/L of sodium to wine due to ion-exchange mechanism (still a very low-sodium food product)

Sparkalloid Fining

- Sometimes Bentonite fining fails to clarify and/or heat stabilize a white wine

- A **working model** that explains this failure states that:

  (1) Proteins near their <u>isoelectric point</u> at wine pH lack significant electrostatic charge to react with Bentonite

  (2) To remove these proteins (and related negatively charged colloidal materials), a fining agent with a strong POSITIVE charge is required

Sparkalloid

- Sparkalloid is a proprietary fining agent with a strong POSITIVE electrostatic charge (Scott Labs; original "hot mix" most effective)
- Alginate (polysaccharide derived from brown seaweed) bound to diatomaceous earth to allow fast settling time
- Very effective; gentle on aroma and color given recommended dose (0.5-1.5 g/L)
- Very "thick" lees formation

Sparkalloid

- Daniel Pambianchi (2008) notes:

  White wine treated with Sparkalloid can take 1-2 months to completely clear; especially if high levels of polysaccharides/pectins present

  Recommends pretreating with enological tannins designed for finishing white wines
  (e.g., 50 PPM of Scott Labs' Tannin Refresh™)

Pambianchi, D. (2008). *Techniques in home winemaking*. Montreal, QC: Véhicule Press.

Silica Gel/Chitin Fining

(Clear proteins with weak charge)

- Kieselsol and Chitosan 2-stage fining (e.g., Super-Kleer KC™) Sparkalloid alternative

Kieselsol/Chitosan Fining

- **Kieselsol™** is 30% silicon dioxide (wt/wt)
- Negative charge; general clarification & protein stability
- Dose: 1 ml/L (Rack in 7-10 days)

- **Chitosan™** is derived from chitin in the exoskeletons of marine zooplankton (shellfish allergy?)
- Strong POSITIVE charge (opposite of Bentonite)
- Dose: 1.5-2 ml/L (dissolved in 10 parts distilled water)
- Takes very long to settle out unless combined with silica gel (e.g., Kieselsol allows racking in about 1 week)
- Saurez, et al. (2007) say Chitosan inhibits Brett. growth

PVPP (Polyvinylpolypyrrolidone)

- Polyclar VT/Polyclar-Wine™ coarse-ground to 140 micron powder
- Nylon derivative that binds-up small polyphenols and yeast
- Gently removes some products of oxidation:
  e.g., browning/off-flavors (quinones)
- Attenuates bitterness due to excess seed tannins
  Hypothesis: This may allow us to extract seed tannins to build structure in cold-climate grapes w/o excessive bitterness

PVPP

- 0.4-1.8 g/L in whites
  0.4-1.5 g/L in reds
  TTB Limit = 7 g/L (60 lbs/1000 gal)
- Will strip some pigmentation from reds but the removal of “browning” can often yield a desirable trade-off
- Use a 10% slurry for bench testing
- Takes 3-10 days to settle-out
- Removal by coarse <u>filtration is reccomended</u>

Reduced Sulfur Odors

- Sulfurous off-odors due to excessive hydrogen sulfide produced by “stressed” yeast can negatively impact a wine’s quality (e.g., rotten egg smell)

- Humans are extremely sensitive to H_2S and its byproducts (mercaptans/thiols and disulfides; cabbage, sewer gas, onion, garlic, canned veggies, burnt rubber)

- Problems will be evident by end of fermentation. H_2S symptoms need to be addresses ASAP before it can be converted to more difficult to handle mercaptans or disulfides.

- Reduced sulfur compounds can mask fruit aromas even if the “classic stink” is not detected.

Treating H_2S Stink

- **Aeration** – H_2S is readily outgassed from wine

- **Sulfiting** plus a splash rack
  SO_2 converts H_2S back to elemental sulfur state
  and protects wine from oxidation damage during aeration
  (problem: Can't sulfite if wine is headed for MLF)

- **Copper sulfate** fining
  Cu^{2+} quickly breaks down the H_2S molecule (minutes)
  Slowly breaks down mercaptans (24 hours)
  Ineffective against the disulfide forms
  Sometimes the required dose exceeds the TTB legal limit of 0.5 PPM residual copper
  Follow-up copper sulfate treatment with Bentonite fining or filtering

- **Copper citrate** fining
  Copper citrate does not ionize into solution if used properly
  Copper citrate bound to bentonite (Kupzit™) is easily filtered out
  yet still reacts with H_2S and mercaptans
  Legal in EU, RSA, Australia and NZ but <u>not in USA/Canada</u>

Reduced Sulfur Odors

- Splash racking will drive off moderate amounts of H_2S gas trapped in the wine
- But…when large amounts of H_2S are present, splash racking can help convert the H_2S to disulfides
- Disulfides may go "underground" only to resurface in bottled wines due to "reductive" chemical reactions during maturation
- Some Australian wineries using <u>Stelvin closures</u> prophylactically treat wine with copper sulfate

  Don't get to use that word in a sentence very often

Copper Sulfate Bench Trials

(1) Prepare a 0.004% STOCK SOLUTION of copper sulfate as follows:
   Add 1 ml of 1% copper sulfate solution to a 250 ml volumetric flask
   Top-up flask to the 250 ml mark and mix thoroughly
(2) Label 5 sample jars/flasks with the numbers 1 through 5.
(3) Add 0 ml, 0.5 ml, 1.0 ml, 1.5 ml and 2.0 ml to sample jars 1-5, respectively[1].
   Each ml of stock solution adds ~0.1 PPM of copper to a 100ml sample.
   Sample #1 is an untreated control. (Note: 1 ml ~= 20 drops)
(4) Add 100 ml of clean (yeast free) wine to each sample jar and mix well.
(5) Wait 1 hour.
(6) Evaluate aroma of samples 2-5 compared to the untreated control (#1):
   If the copper addition successfully eliminated the offending odor, you most likely have an H_2S problem. Treat your wine using the smallest dosage that effectively eliminated the odor. If your wine still stinks, you may have a mercaptan or disulfide problem.
(7) Recap the sample jars & wait another 24 hrs to give mercaptan time to react.
(8) Re-evaluate the aromas. If the extra 24 hours resulted in the elimination of the offensive odor, you probably have a mercaptan problem. Treat your wine with the minimum effective dose of copper sulfate. If your wine still stinks, you probably have a disulfide problem. (Note: Ascorbic acid & sulfite takes several months to convert disulfides back to mercaptans)

See http://www.extension.iastate.edu/wine/treatment-removal-h2s

Wine Filtering

(for the Amateur)

Nominal vs. Absolute Filters

- Most conventional filters mechanically trap undesirable particles through adsorption or sieve-like screening mechanisms.
- This filtering can be thought of as a statistical process. Hence, a filter can be rated to block 99% of particulate matter of a given size.
- Such filters are said to have **NOMINAL** ratings.

- Filtering 99% of Bentonite from a wine is a readily interpretable statistic; but what does it mean to filter-out 99% of microbes (since they can reproduce themselves; often with great vigor)

"Absolute" Filters

- To achieve microbial stability, one needs a filter that will block ALL particulate matter and/or organisms of a specified size.
- Such filters are referred to as having an **ABSOLUTE** rating or specification
- Modern **membrane filters** have been developed for the pharmaceutical and beverage industries to support small-lot ABSOLUTE filtering of air and liquids.
  [Can amateurs successfully apply this technology?]

Common Amateur Filtering Setups

(All are based on <u>Nominal</u> Specifications)

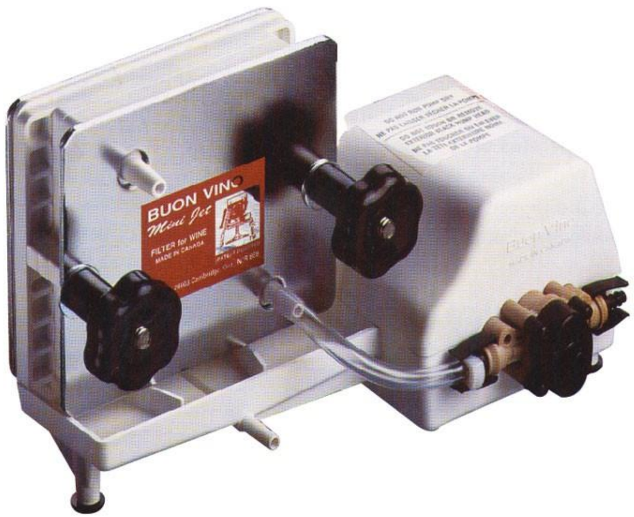
- *Enolmatic* Cartridge Filter
- *Buon Vino* MiniJet/SuperJet pad filters
- Whole-house water filters (Home brew)

Enolmatic Filler/Filter Combo

Quality filter housing for NOMINAL FILTERING of wine using EnolMatic vacuum filler
Superior filter cartridges with locking tabs and gaskets but still a NOMINAL filter.

5 micron	Polish reds
1 micron	Polish whites
0.5 micron	~~Sterile filter~~ (knock down yeast in sweetened whites) (but still need potassium sorbate)

Buon Vino Mini/Super-Jet Filters



Uses built-in transfer pump to push wine through proprietary filter pads
Somewhat difficult to clean and sanitize
The MiniJet is a notorius "leaker". People seem to "love" their SuperJets

Coarse (6 micron)
Polishing (2 micron)
~~Sterile~~ (0.5 micron)   At best, this is a "near stabilizing" filter
(Sweet wine still requires potassium sorbate)

Whole-House Water Filters

(Re-Purposed for Home Winemaking)

When modified with a pair of “hose barb” fittings, a generic whole-house water filter can be used as an in-line wine filter. The wine can be pulled through the filter canister with a vacuum pump or pushed through using inert gas or a small transfer pump.

Again, filtering is **NOMINAL** and inexpensive 20, 10, 5 and 1 micron filters are available.

Absolute Filtering

PolyEtherSulfone (PES) membrane filters have absolute ratings of 99.999%

The "de facto" standard format for the wine industry is the 2-226 or "Code 7" cartridge (locking tab, double gasket, single-open end configuration) available in 10, 20 and 30-inch lengths

Absolute membrane filters with a **0.45 micron** rating are used for "sterile" filtering of wine. All yeast and virtually all of the "problem" bacteria will be blocked.

Special filter housing are required to use these membrane cartridges

Membrane Filter Cartridge Housing

Stainless 10” Membrane Filter Housing

Pressure gauge for monitoring filter performance and membrane integrity tests

Sweet wines that are properly filtered through an 0.45 micron absolute membrane would not require potassium sorbate additions.

Experiments are currently in-progress.

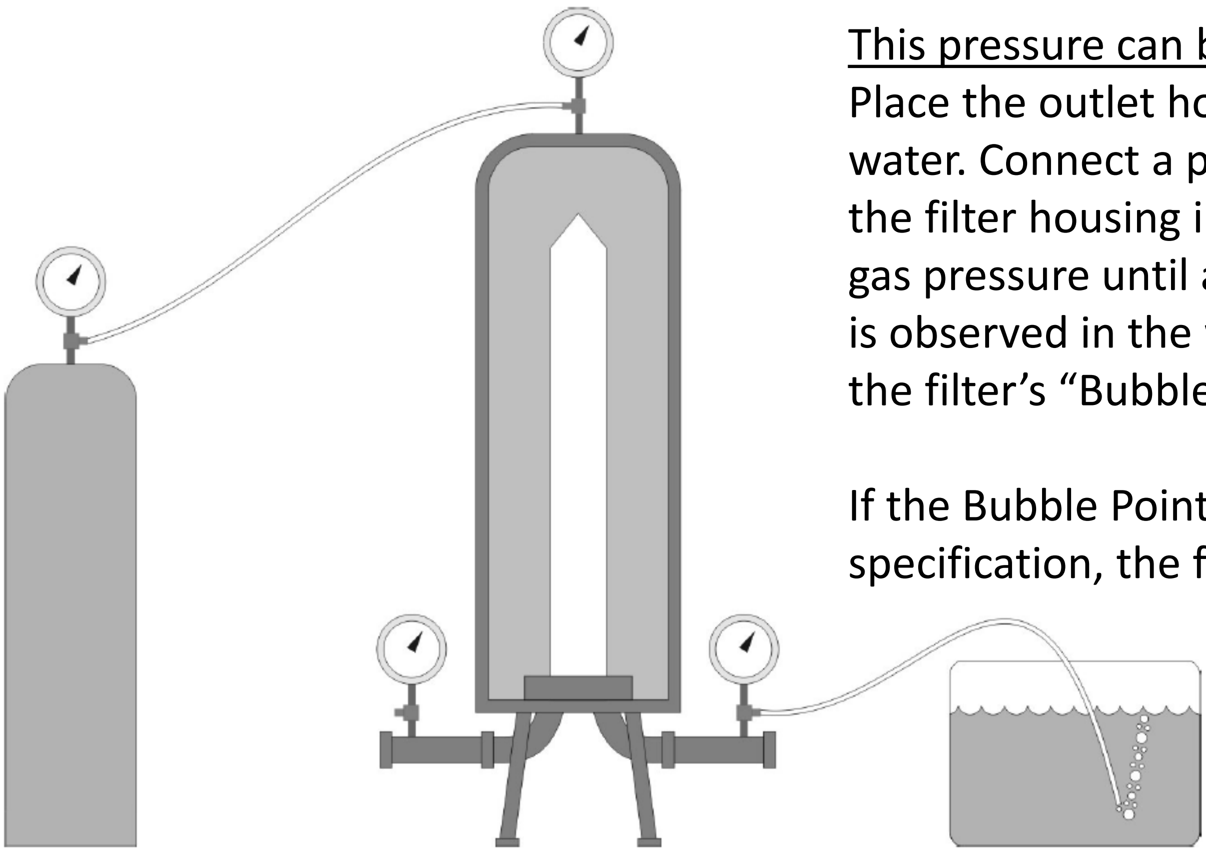
Bubble Point Test

(Verifies Absolute Membrane Filter Integrity)

After thoroughly "wetting" a membrane filter, its integrity can be determined by measuring how much pressure is required to force an inert gas through the membrane.

<u>This pressure can be determined as follows</u>: Place the outlet hose in a vessel filled with water. Connect a pressurized gas cylinder to the filter housing input. Gradually increase the gas pressure until a regular stream of bubbles is observed in the water. This gas pressure is the filter's "Bubble Point".

If the Bubble Point meets or exceeds the mfg's specification, the filter's integrity is assured.



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